PATENTS & DESIGNS
The Patent Office
COPYRIGHT • TRADE MARKS

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 22 August 2003

Patents Form 1/77

Patents Act 1977
(Rule 16)

The Patent Office

15AUG02 E741364-1 D01063
P01/7700 0.00-0219006.4

THE PATENT OFFICE
D
15 AUG 2002
NEWPORT

The Patent Office

Cardiff Road
Newport
South Wales
NP9 1RH

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

1. Your reference	MHS.P52112GB
2. Patent application number *(The Patent Office will fill in this part)*	0219006.4 15 AUG 2002
3. Full name, address and postcode of the or of each applicant *(underline all surnames)*	Kiddielink Limited 90 Woodcote Road Caversham Reading RG4 7EY
Patents ADP number *(if you know it)*	8446072001
If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom
4. Title of the invention	Locating System, Device and Method
5. Name of your agent *(if you have one)*	Marks & Clerk
"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	4220 Nash Court Oxford Business Park South Oxford OX4 2RU United Kingdom
Patents ADP number *(if you know it)*	7271125001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant, or* *c) any named applicant is a corporate body.* *See note (d))*	Yes

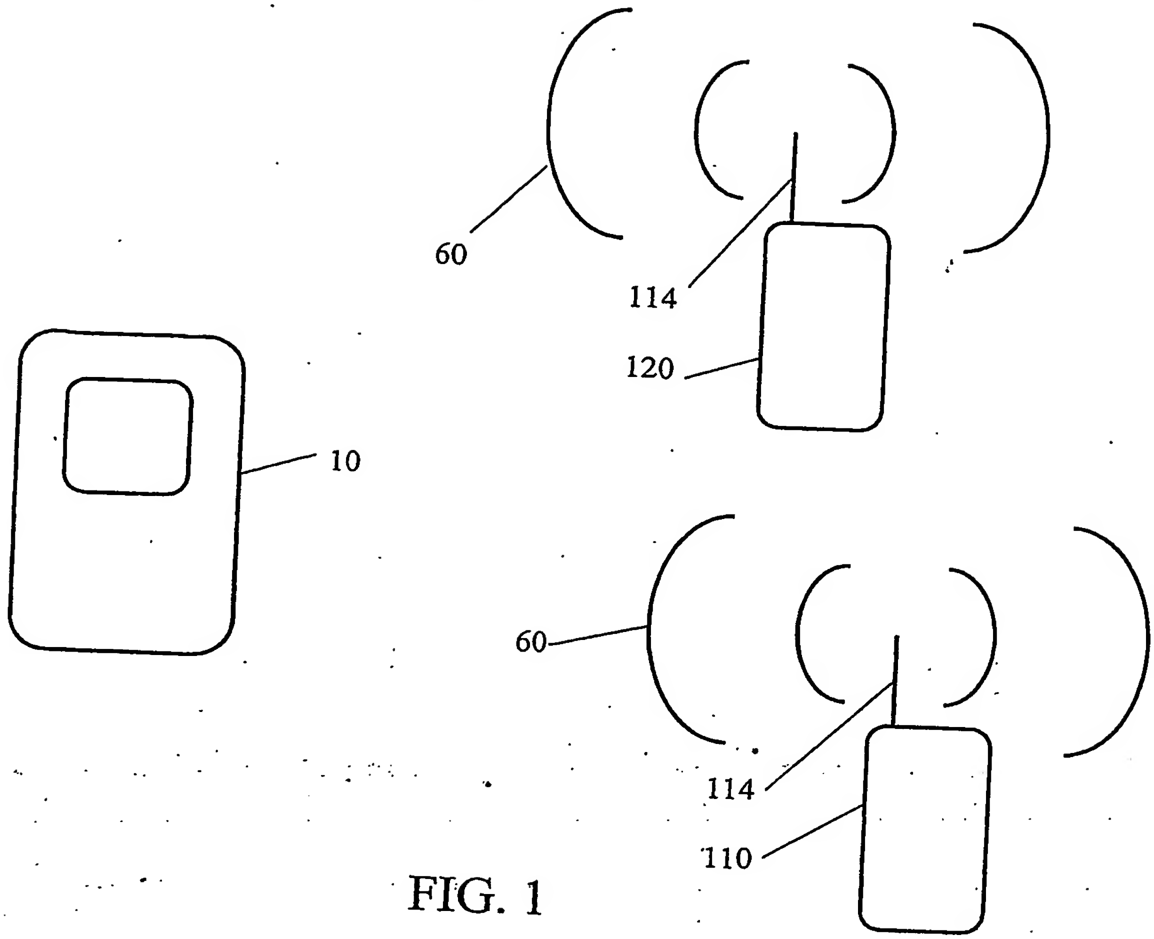
60
114
120
10
60
114
110

FIG. 1

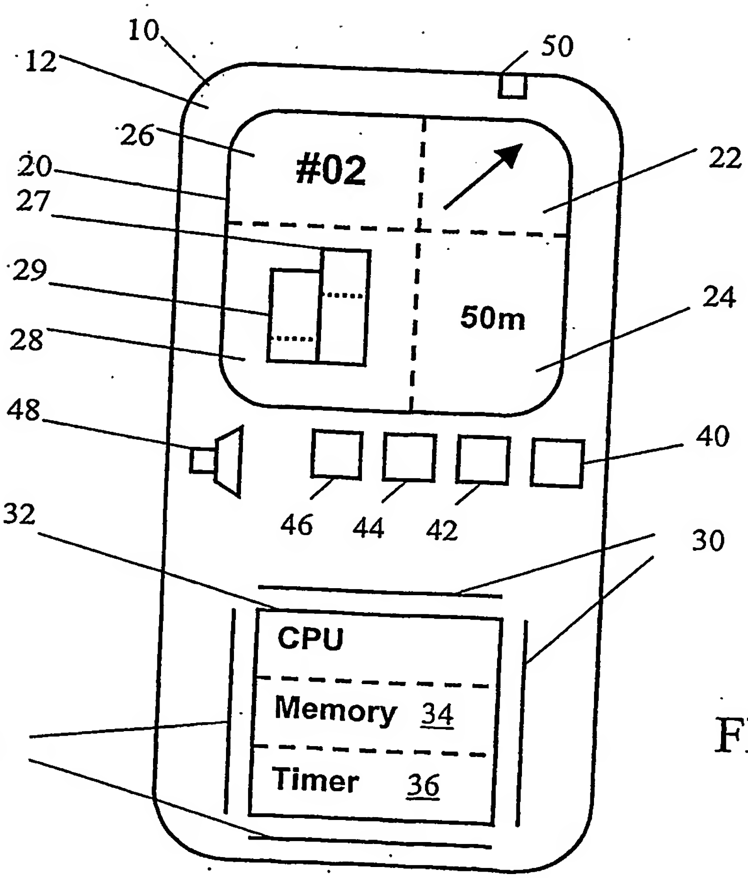
10
12
50
26
#02
20
22
27
29
28
50m
24
48
40
46
44
42
32
30
CPU
Memory 34
Timer 36
30

FIG. 2

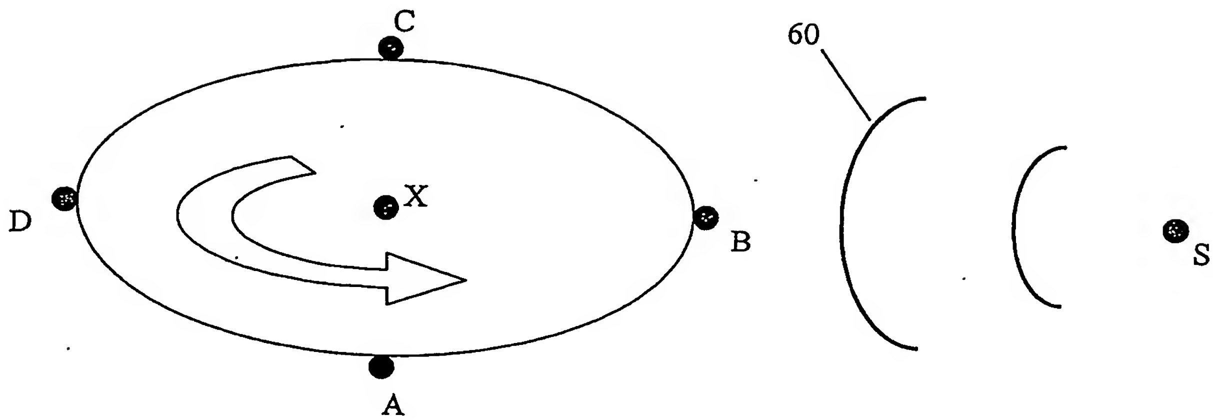

FIG. 3

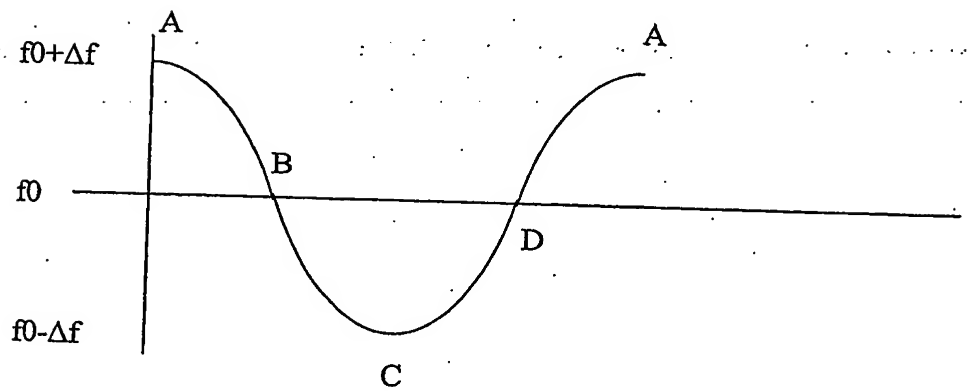

FIG. 4

LOCATING SYSTEM, DEVICE AND METHOD

The present invention relates to a locating system, a locating device for use in that system and a locating method.

The present invention finds particular application in a technique for locating a child wearing or carrying a suitable device, but not all embodiments of the present invention are limited to a child locating technique. It will be appreciated that the invention can also be used for locating persons other than children, animals or indeed objects equipped with a suitable device. However, for the sake of simplicity the present invention will be described with particular reference to a child locating technique.

Various techniques are known which enable a parent (or guardian) to monitor the position, direction or distance of a device worn or carried by a child with respect to a device operated by the parent.

For the purpose of the discussion of the prior art and the description of the present invention the device operated by the parent will be referred to as the "parent unit", and the device carried or worn by the child will be referred to as the "child unit". The term "locating device" as used in the appended claims covers, inter alia, the parent unit, and the term "further device" used in the appended claims covers, inter alia, the child unit.

US 6,075,442 discloses a child locator system having three narrow beam antennas arranged at three sides of a parent unit. Visual indicators are associated with each of the antennas. The strength of any signal received from a child unit is detected by each antenna, and the associated indicators are illuminated in correspondence with the received signal strength. This is used as an indication of the direction from which the radio signals emanate, i.e. the direction of the child unit.

Several disadvantages are associated with this known system. Firstly, the detected signal strength cannot provide a reliable indication of the distance between the parent unit and the child unit. Secondly, if the child unit is not within one of the narrow

angular ranges of the parent unit antennas then no (reliable) reading will be possible. It is then necessary to rotate the parent unit so that it "points" to the child unit.

It is an object of at least the preferred embodiments of the present invention to provide a locating device, system or method which addresses the above disadvantages. Hence at least in its preferred embodiments the present invention seeks to provide a locating technique which enables a user (parent) to determine positional information of a transmitting device with increased reliability and efficiency.

Aspects of the present invention are defined in the independent claims.

Preferred features are as set out in the dependent claims.

Some preferred embodiments of the invention will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 schematically shows a locating system according to an embodiment of the present invention;
Figure 2 shows details of a locating device according to the present invention;
Figure 3 illustrates the principles of the Dopplescant effect; and
Figure 4 shows a frequency diagram obtainable by the Dopplescant effect.

The system shown in Figure 1 comprises a parent unit 10 and two child units 110 and 120. Both child units are able to transmit electromagnetic signals 60 towards the parent unit by means of antenna 114. Although shown as external, antenna 114 is preferably incorporated into the body of the child units.

Referring now to Figure 2, the parent unit 10 comprises a body 12 on which is mounted a display 20. The parent unit 10 further comprises a processing unit 32 and four antennas 30. The four antennas are sheet antennas which extend into the paper plane of Figure 2 and are typically a few centimetres wide and long. Each antenna plane is

oriented at 90° to the planes of neighbouring antennas so that they are approximately arranged around a square.

Each antenna is a uni-directional antenna, the angular range covered by each antenna being somewhat more than 90°, e.g. 120°, so that the angular ranges covered by neighbouring antennas overlap.

Embodiments of the present invention make use of the "Dopplescant effect". Whilst this effect is well known, it is believed that no personal locating device exists which makes use of the Dopplescant effect, and therefore its principles are briefly outlined here. The Dopplescant effect can be observed with at least three spaced antennas, but for simplicity the principle will be explained using an arrangement of four antennas.

It is well-known that the frequency of a signal as received by a moving receiver depends on its relative speed towards or away from the source of the signal (the Doppler effect). For a receiver moving along a circular path as indicated in Figure 3 the frequency of signal 60 as perceived by the moving receiver will oscillate between a minimum value of $f_0 - \Delta f$ and a maximum value of $f_0 + \Delta f$ around the true frequency f_0 of the signal 60. Figure 4 shows a graph of the perceived frequency versus time, i.e. as the moving receiver passes through points A, B, C and D shown in Figure 3. This illustrates one example of the well-known Doppler effect.

Pursuant to the invention the Dopplescant effect can be observed with an antenna arrangement as that included in the parent unit shown in Figure 2. Figures 3 and 4 are here also used to illustrate the Dopplescant effect. The points A, B, C and D denote the centre points of the four static antennas 30 of the parent unit. During reception operation the four antennas are switched sequentially, with temporal overlap between adjacent antennas, i.e. first only antenna A is switched for reception, then A and B, then B only, then B and C, then C only etc. This sequential switching of four static antennas simulates the circular movement of a single moving antenna, and a frequency shift can be observed, as with the Doppler effect. This phenomenon is used, according to the invention, to determine the direction of the child unit.

Assuming the signal source S is located on a straight line through points B and D and is to the right of point B (as shown in Figure 3) then the perceived frequency is highest when only antenna A is receiving, and lowest when only antenna C is receiving. Through appropriate processing of the signal as received by the four antennas it can be determined that the signal source S is in the direction of antenna B (with respect to the "axis of rotation" X. In other words, considering the timing diagram shown in Figure 4, by detecting negative going zero-crossings of the perceived frequency of signal 60 one can determine the antenna which is closest to the signal source S (or which indicates the direction of the signal source S).

The operation of a first embodiment of the present invention (with only one child unit 110) is as follows. The child unit 110 constantly transmits a signal 60, inter alia towards the parent unit 10. The four antennas 30 of the parent unit are switched under the control of CPU 32 as described above, i.e. according to the sequence A, A+ B, B, B+ C etc. In embodiments of the present invention the direction of the signal source, i.e. child unit 110, is determined as outlined above. CPU 32 outputs this positional information by instructing display 20 to indicate the approximate direction within region 22 on display 20. This indication of direction can take the form of an arrow which can assume eight different directions, corresponding to the direction of each of the four antennas, and the four directions between two adjacent antennas.

According to a second embodiment the distance between the child unit 110 and the parent unit 10 is also estimated. In the second embodiment the direction determination according to the first embodiment is carried out first. Thereafter that antenna or those antennas which are closest to the child unit 110 are used for estimating the distance. If the child unit 110 has been determined as being located within the range of e.g. antenna A only, then only this antenna will be used for distance estimation. If the child unit 110 has been determined as being located within the overlap between the angular ranges of e.g. antennas A and B, then those are used.

In order to estimate the distance the CPU 32 causes the relevant antenna(s) to transmit a distance estimation signal towards the child unit 110. On transmission of this distance estimation signal the CPU 32 starts timer 36 running. The distance estimation signal is detected by child unit 110, which in response transmits a response signal towards the parent unit 10. The return signal is detected by the relevant antenna(s), and on receipt of the return signal the CPU 32 stops timer 36. In other words, timer 36 measures the time that the signals have taken to travel from the parent unit to the child unit and back to the parent unit, plus any processing delays. The measured time is processed by CPU 32 so as to eliminate the processing delays, and so as to estimate the distance between the parent unit 10 and the child unit 110, using standard mathematics. The result is displayed on display 20 in distance indication region 24.

According to a third embodiment, which can be based on either the first or second embodiment, the locating system comprises parent unit 10 and two or more child units 110 and 120, as shown in Figure 1. The principle of operation of the direction determination and/or distance estimation is the same as in the first and second embodiment. However, in order to enable the parent unit 10 to distinguish between the signals 60 received from different child units each child unit transmits electromagnetic signals with a particular signature associated with that child unit. This signature can be included in the signal 60 by any suitable modulation technique, but it is preferred that a 24 or 32 bit frequency modulated signature is employed. Using a 24 bit signature generates 16 million unique codes, which makes each child unit unique for all practical purposes. This ensures that the parent unit will only respond to a particular child unit. To this end the parent unit includes a memory 34 for storing the signature of one or more child units. The CPU 32 is then able to compare the signature of a received signal with the signature stored in the memory 34. Buttons 42 and 44 are provided on parent unit 10 for selecting a particular one of the child units, and the direction of only this child unit is indicated on display 20.

The signature can be pre-stored in memory 34. Alternatively, the parent unit can be "taught" the signature of one or more child units. To this end, buttons 42 and 44 can be used by the parent to select a particular child unit (a corresponding number is then

displayed in region 26 on display 20). In order to teach the parent unit 10 the signature of a particular child unit the two units can be connected by cable via connector 50 (a corresponding connector is provided on the child unit), and a "learn button" 46 is depressed on the parent unit after connection of the two units. On depression of this button the child unit informs the parent unit of its signature via the cable connection.

In a further development it is possible to display the direction and/or distance for several child units simultaneously, for example using different colours to distinguish between the different child units.

The fourth embodiment can again be based on any of the first to third embodiments. The parent unit according to the fourth embodiment additionally has a display region 28 for displaying the battery charging level 27 of the parent unit and/or also the battery charging level 29 of one or more child units. Information about the battery charging level of the child unit is transmitted within the signal sent from child unit 110 to parent unit 10.

Operation of the fifth embodiment of the present invention is again based on any of the first to fourth embodiments. However, according to the fifth embodiment the child unit(s) do/does not continuously transmit signal 60. Instead, child unit 110 transmits signal 60 only on receipt of an initial signal from the parent unit 10. This initial signal would typically only be transmitted when the parent has lost eye contact with the child. The initial signal can, for example, be transmitted on depression of the "on" key 40 on the parent unit, and each time a different child unit is selected by means of keys 42 and 44 (in case two or more child units are used).

The sixth embodiment is again based on any of the first to fifth embodiments. However, the parent unit 10 of the sixth embodiment additionally has for example a load speaker 48 for alerting the parent in case the distance between the parent unit and a child unit has become greater than a predetermined distance (which may be selected by the parent, or fixed).

Additionally, or alternatively, the loud speaker 48 can also be used to alert the parent if no signal 60 is received from the child unit 110.

The seventh embodiment can be based on any of the previous embodiments where more than one child unit is present. According to the seventh embodiment the parent unit cyclically "interrogates" all child units, sequentially. That is, for each child unit the following sequence is performed:

1. transmission of an initial signal from the parent unit to a child unit.
2. transmission of the signal 60 from the child unit to the parent unit for direction determination.
3. (optional) transmission of the distance estimation signal from the parent unit to the child unit and transmission of the return signal from the child unit to the parent unit for distance estimation.

In step 1. above the initial signal transmitted from the parent unit to the child unit is preferably also coded with a particular signature to which only one particular child unit responds.

Although the invention has been described in terms of preferred embodiments as set forth above, it should be understood that these embodiments are illustrative only and that the claims are not limited to those embodiments. Those skilled in the art will be able to make modifications and alternatives in view of the disclosure which are contemplated as falling within the scope of the appended claims.

CLAIMS:

1. A child locating system comprising a child locating device, and a further device carried or worn by a child, the further device comprising transmission means for transmitting an electromagnetic signal towards said child locating device,

said child locating device comprising:

at least three spaced antennas for receiving said electromagnetic signal;

switching means for switching the at least three antennas in such a way as to obtain a Dopplescant effect;

processing means for processing the electromagnetic signal as received by the antennas; and

outputting means for producing an output indicative of the direction of the further device with respect to said child locating device.

2. A locating system according to claim 1, wherein the locating device comprises at least four spaced antennas.

3. A locating system according to claim 1 or claim 2, wherein the antennas are unidirectional antennas and the angular ranges covered by neighbouring antennas overlap.

4. A locating system according to any preceding claim, wherein the locating device further comprises distance determining means for determining the distance between the locating device and the further device, and wherein the outputting means is arranged to produce an output indicative of the distance between the locating device and the further device.

5. A locating system according to claim 4, wherein the distance determining means comprises means for causing one of said antennas to transmit a further electromagnetic signal towards the further device, means for causing one of said antennas to receive a return signal from the further device, time measuring means for measuring the time between transmission of the further signal and receipt of the return signal, and

estimating means for estimating the distance between the locating device and the further device based on the measured time.

6. A locating system according to claim 5, wherein the means for causing one of said antennas to transmit the further signal is arranged to cause that antenna which is closest to the further device to transmit the further signal.

7. A locating system according to any preceding claim, wherein the outputting means comprises a display for displaying the direction of the further device with respect to the locating device.

8. A locating system according to claim 7 as dependent on any one of claims 4 to 6, wherein the display is further arranged to display the distance between the locating device and the further device.

9. A locating system according to any of claims 4 to 6 or 8, or claim 7 as dependent on any of claims 4 to 6, wherein the locating device further comprises notifying means for notifying a user of the locating device if the distance between the locating device and the further device is larger than a predetermined value.

10. A locating system according to any preceding claim, wherein the locating device further comprises means for alerting a user of the locating device if no electromagnetic signal is received from the further device.

11. A locating system according to any preceding claim, wherein the locating device further comprises means for causing one of said antennas to transmit an initial electromagnetic signal which is arranged to cause the further device to transmit said electromagnetic signal.

12. A locating system according to any preceding claim, wherein the further device is arranged to transmit battery charging level information to the locating device, and the

outputting means is arranged to produce an output indicative of the battery charging level of the further device, based on the battery charging level information.

13. A locating device for use in a locating system comprising said locating device and a further device, the further device comprising transmission means for transmitting an electromagnetic signal towards said locating device, the electromagnetic signal having a signature associated with the further device;

said locating device comprising:

signature storage means for storing a representation of the signature of the further device;

at least three spaced antennas for receiving said electromagnetic signal;

switching means for switching the at least three antennas in such a way as to obtain a Dopplescant effect;

processing means for processing the electromagnetic signal as received by the antennas so as to detect the signature of the received signal, and to compare the signature as detected with the representation of the signature as stored;

and outputting means for producing, if the signature as detected corresponds to the representation of the signature as stored, an output indicative of the direction of the further device with respect to said locating device.

14. A locating device according to claim 13, comprising at least four spaced antennas.

15. A locating device according to claim 13 or claim 14, wherein the antennas are unidirectional antennas and the angular ranges covered by neighbouring antennas overlap.

16. A locating device according to any of claims 13 to 15, further comprising distance determining means for determining the distance between the locating device and the further device, wherein the locating device is arranged to produce an output indicative of the distance between the locating device and the further device.

17. A locating device according to claim 16, wherein the distance determining means comprises means for causing one of said antennas to transmit a further electromagnetic signal towards the further device, means for causing one of said antennas to receive a return signal from the further device, time measuring means for measuring the time between transmission of the further signal and receipt of the return signal, and estimating means for estimating the distance between the locating device and the further device based on the measured time.

18. A locating device according to claim 17, wherein the means for causing one of said antennas to transmit the further signal is arranged to cause that antenna which is closest to the further device to transmit the further signal.

19. A locating device according to any of claims 13 to 18, wherein the outputting means comprises a display for displaying the direction of the further device with respect to the locating device.

20. A locating device according to claim 19 as dependent on any one of claims 16 to 18, wherein the display is further arranged to display the distance between the locating device and the further device.

21. A locating device according to any of claims 16 to 18 or 20, or claim 19 as dependent on any of claims 16 to 18, further comprises notifying means for notifying a user if the distance between the locating device and the further device is larger than a predetermined value.

22. A locating device according to any of claims 13 to 21, further comprising means for alerting a user if no electromagnetic signal is received from the further device.

23. A locating device according to any of claims 13 to 22, further comprising means for causing one of said antennas to transmit an initial electromagnetic signal which is arranged to cause the further device to transmit said electromagnetic signal.

24. A locating device according to any of claims 13 to 23, arranged to communicate with two or more said further devices, wherein the signature storage means is arranged to store the signatures of each further device, the signatures of each further device being different, and wherein the outputting means is arranged to produce an output indicative of the direction and/or the distance of each further device with respect to the locating device.

25. A locating device according to claim 24, wherein the outputting means is arranged to produce simultaneously for each further device an output indicative of the direction and/or the distance with respect to the locating device.

26. A locating device according to claim 24, further comprising means for enabling a user to select a said further device, and wherein the outputting means produces an output indicative of the direction and/or the distance for the selected further device with respect to the locating device.

27. A locating device according to any of claims 13 to 26, wherein the locating device is arranged to receive battery charging level information from the or each further device, and the outputting means is arranged to produce an output indicative of the battery charging level of the or each further device, based on the battery charging level information.

28. A locating system comprising the locating device according to any of claims 13 to 27, and one or more said further devices.

29. A locating system according to claim 28, wherein a said further device is arranged to be carried or worn by a person, preferably a child.

30. A method of determining, by means of a locating device, information indicative of the direction of a child with respect to said locating device, the child wearing or carrying a further device, the method comprising:

transmitting an electromagnetic signal from the further device towards said locating device;

receiving said electromagnetic signal at said locating device, using at least three spaced antennas which are switched in such a way as to obtain a Dopplescant effect;

processing the electromagnetic signal as received by the antennas; and

producing an output indicative of the direction of the further device with respect to said locating device.

31. A method of determining, using a locating device, information indicative of the direction of a further device with respect to said locating device, the method comprising:

storing a representation of a signature associated with the further device in said locating device;

transmitting an electromagnetic signal from the further device towards said locating device, the electromagnetic signal including the signature associated with the further device;

receiving said electromagnetic signal at said locating device, using at least three spaced antennas which are switched in such a way as to obtain a Dopplescant effect;

processing the electromagnetic signal as received by the antennas so as to detect the signature of the received signal;

comparing the signature as detected with the representation of the signature as stored; and

if the signature as detected corresponds to the representation of the signature as stored, producing an output indicative of the direction of the further device with respect to said locating device.

32. A method according to claim 30 or 31, wherein at least four spaced antennas are used to receive said electromagnetic signal.

33. A method according to any of claims 30 to 32, comprising using unidirectional antennas, wherein the angular ranges covered by neighbouring antennas overlap.

34. A method according to any of claims 30 to 33, further comprising determining the distance between the locating device and the further device, and producing an output indicative of the distance between the locating device and the further device.

35. A method according to claim 34, wherein determining the distance comprises transmitting a further electromagnetic signal from one of said antennas towards the further device, receiving a return signal from the further device at one of said antennas, measuring the time between transmission of the further signal and receipt of the return signal, and estimating the distance between the locating device and the further device based on the measured time.

36. A method according to claim 35, wherein the further signal is transmitted from that antenna which is closest to the further device.

37. A method according to any of claims 34 to 36, comprising displaying the distance between the locating device and the further device.

38. A method according to any of claims 34 to37, further comprising notifying a user of the locating device if the distance between the locating device and the further device is larger than a predetermined value.

39. A method according to any of claims 30 to 38, comprising displaying the direction of the further device with respect to the locating device.

40. A method according to any of claims 30 to 39, further comprising alerting a user of the locating device if no electromagnetic signal is received from the further device.

41. A method according to any of claims 30 to 40, further comprising transmitting towards the further device an initial electromagnetic signal which is arranged to cause the further device to transmit said electromagnetic signal.

42. A method according to claim 31 or any of claims 32 to 41 as directly or indirectly dependent on claim 31, comprising storing the signatures of two or more said further devices, the signatures of each further device being different, and producing an output indicative of the direction and/or the distance of each further device with respect to the locating device.

43. A method according to claim 42, comprising producing simultaneously for each further device an output indicative of the direction and/or the distance with respect to the locating device.

44. A method according to claim 42, further comprising enabling a user to select a said further device, and producing an output indicative of the direction and/or the distance for the selected further device with respect to the locating device.

45. A method according to any of claims 30 to 44, further comprising transmitting battery charging level information from the or each further device to the locating device, and producing, at the locating device, an output indicative of the battery charging level of the or each further device, based on the battery charging level information.

46. Use of a Dopplescant technique in a child locating device which is arranged to receive a signal transmitted by a further device carried or worn by a child.

47. A locating device, a system, a method or a use, substantially as herein described with reference to, or as illustrated in, the accompanying drawings.

ABSTRACT

CHILD LOCATING AND TRACKING APPARATUS

A locating system is disclosed, which can be used for locating a child. The system comprises a child locating device (parent unit) and a further device (child unit) carried or worn by the child. The child unit transmits an electromagnetic signal towards the parent unit, and the parent unit receives the electromagnetic signal, using at least three spaced antennas which are switched in such a way as to obtain a Dopplescant effect. The received signal is processed and the direction of the child unit with respect to the parent unit is displayed on a display on the parent unit. Distance measurement is also possible. The system can be used with several child units.

(Fig.2)